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WITNESS my hand this
Twenty-ninth day of August 2003

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P/00/009 25.5.91
Regulation 3.2

AUSTRALIA

Patents Act 1990

PROVISIONAL SPECIFICATION

Invention Title:

METHOD OF FARMING AND HARVESTING CRUSTACEANS

The invention is described in the following statement:

[redacted]

Method of Farming and Harvesting Crustaceans

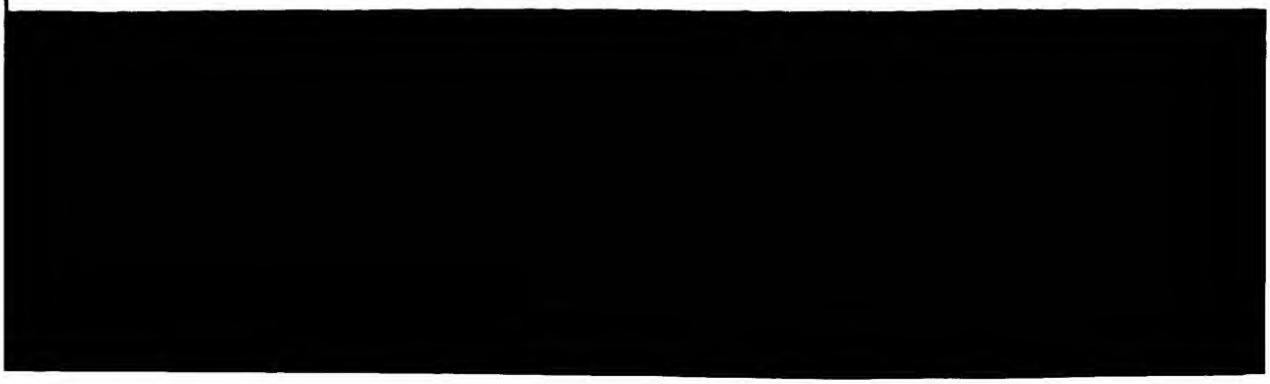
FIELD OF INVENTION

The present invention relates to farming and harvesting crustaceans in a controlled environment. The present invention has particular but not exclusive application for automating farming and harvesting crustaceans. The term crustaceans includes crabs, lobsters, Moreton Bay bugs, prawns and any other suitable crustaceans that are capable of molting. Crabs and in particular mud and blue swimmer crabs are described in the specification by way of example of crustaceans and the invention is not limited to crabs but encompasses the abovementioned crustaceans.

PRIOR ART

Soft-shelled crabs have become a delicacy and a high demand has developed for the product particularly by restaurants in Australia and overseas. The soft-shelled crab is the crab meat product remaining after the crab has molted and discarded its shell. The soft-shelled crab can consequently be eaten as a whole without the interference of the shell. However to obtain the soft-shelled crab product, the crab must be harvested within three hours of molting otherwise a new shell begins to form making the product unmarketable.

Unfortunately, the wild soft-shelled crabs are seasonal and there are restrictions on crab catch sizes. To meet market demand attempts have been made to adapt soft-shelled crabs to aquaculture farming. Aquaculture farming of soft-shelled crabs involves growing them in large earthen ponds and removing individual crabs to holding tanks when colouration develops on the legs and back paddle fins indicating that they are about to molt. In the tanks the crabs undergo 24 hour human surveillance to identify when the crabs have molted. Unfortunately, the current practice of aquaculture farming suffers a number of problems including a relatively low crab yield because of the cannibalistic nature of the crabs, the reliance on 24 hour manual labour to monitor and remove the crabs when molting has occurred, the variable quality of the soft-shell crab meat.



OBJECT OF THE INVENTION

It is an object of the present invention to provide a method of farming and harvesting crustaceans that overcomes at least in part one or more of the aforementioned problems.

SUMMARY OF THE INVENTION

In one aspect the present invention broadly resides in a method of farming and harvesting crustaceans including

obtaining a plurality of crustaceans;

positioning each of said crustaceans in individual holding means;

monitoring each of said crustaceans to determine whether they have molted; and

harvesting each of the molted crustaceans.

The term crustaceans refers to crabs, lobsters, Moreton Bay bugs, prawns and any other suitable crustaceans that are capable of molting.

Holding means preferably includes a basket for containing a single crustacean. The basket preferably has a waste outlet and a clean water inlet. A plurality of baskets are preferably arranged on trays. The trays preferably have a recess in the floor to allow collection of waste from each basket. There are preferably a plurality of trays supported on a racking system. The racking system may be a single level but preferably a multi-level system. The baskets, trays and racking system are preferably arranged to provide a reproducible modular system for housing the crustaceans.

Monitoring preferably includes determining whether there are two or more crustacean-shaped bodies within the holding means wherein one body is the exoskeleton while the other is the molted crustacean. Monitoring may be achieved by observation by a person but preferably by a sensor means. A sensor means preferably includes a camera adapted to send an image to a processor having the software to process the image and determine the presence of two bodies.

Monitoring may also include periodic feeding of the crustaceans with a nutrient feed. In a preferred embodiment the sensor means is able to determine the size of the crustacean and enable feed to be provided as a percentage of the body weight of the crustacean. The amount of feed to be provided to the crustacean may range between 3 and 15% of its body weight and more preferably 7% of its body

weight. The sensor means is preferably able to determine whether there is feed remaining in the holding means and increase or reduce the amount of feed subsequently provided to the crustacean.

Harvesting preferably includes moving the crustacean from the holding means and placing it in a collection container maintained at a temperature to slow activity. Preferably the temperature of the collection container is between 4 and 20 degrees. Harvesting may include determining whether the molted crustacean in the collection container is of an acceptable marketable size. If the molted crustacean are determined to be of a marketable size they are prepared for sale but if not they are returned to a holding means for further growth.

In another aspect the invention broadly resides in an automated system of farming and harvesting crustaceans including

modular housing means including a plurality of holding means for individual containment of crustaceans, said holding means preferably is supported on a racking system;

monitoring means including a sensor means operatively associated with a processor adapted to instruct provision of a desired amount of feed to each holding means and determine whether molting has occurred and instructing harvesting where the crustacean has molted;

feeding means for the provision of feed to each of the holding means; and

harvesting means for harvesting molted crustaceans from their holding means.

The modular housing means preferably includes an arrangement of holding means, trays and a racking system as described above.

Sensor means preferably includes a camera capable of taking images of the inside of the holding means.

The harvesting means preferably includes an arm capable of grabbing and lifting the holding means in order to remove the molted crustacean. The monitoring means, feeding means, and the harvesting means is preferably mounted as a mobile unit able to check each holding means on the racking system.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the present invention be more readily understood and put into practical effect, reference will now be made to the accompanying drawings wherein:

Figure 1 is a diagrammatic view of a basket holding a single crab;

Figure 2 is a diagrammatic view of a tray for supporting a plurality of baskets;

Figure 3 is a further diagrammatic view of a tray supporting a plurality of baskets;

Figure 4 is a diagrammatic view of the racking system of the preferred embodiment;

Figure 5 is a diagrammatic view of the camera and feeding mechanisms of the preferred embodiment;

Figure 6 is a diagrammatic view of the monitoring robot;

Figure 7 is a diagrammatic side view of the docking unit, monitoring robot and racking system;

Figure 8 is a diagrammatic view of the harvesting mechanism on the monitoring robot;

Figure 9 is a plan diagrammatic view of the monitoring robot and docking unit;

Figure 10 is a plan diagrammatic layout view of the racking system for farming and harvesting crustaceans; and

Figure 11 is a side diagrammatic view of the racking system for farming and harvesting crustaceans.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to figures 1, 2 and 3 there is shown a basket 10 for containing a single crustacean, which in figure 1 is a crab 11. The basket 10 has an aperture 12 midway in a side wall to allow introduction of clean salt water. The floor 13 of the container 10 has two adjacent slots 14 to allow for the discharge of waste. The floor 13 is supported by two triangular-shaped feet 15. The tray 17 includes an elongated pipe 18 through which clean salt water is passaged. Each of the baskets 10 is positioned against the pipe 18 in a manner where the floor 13 of the basket 10 is substantially horizontal. Floor 19 of tray 17 is substantially V-shaped and has an internal recess 20 that leads to a discharge outlet 21 where waste and water are discharged. Waste from the baskets 10 collects in the recess 20. The pipe 18 has a series of apertures 22 that align with apertures 12 in baskets 10 to allow introduction of clean salt water into baskets 10. The trays 17 may contain any suitable number of baskets 10 and a group of baskets 10 can be separated from each other by a bracket 23. In the preferred embodiment, there are eighteen baskets per tray.

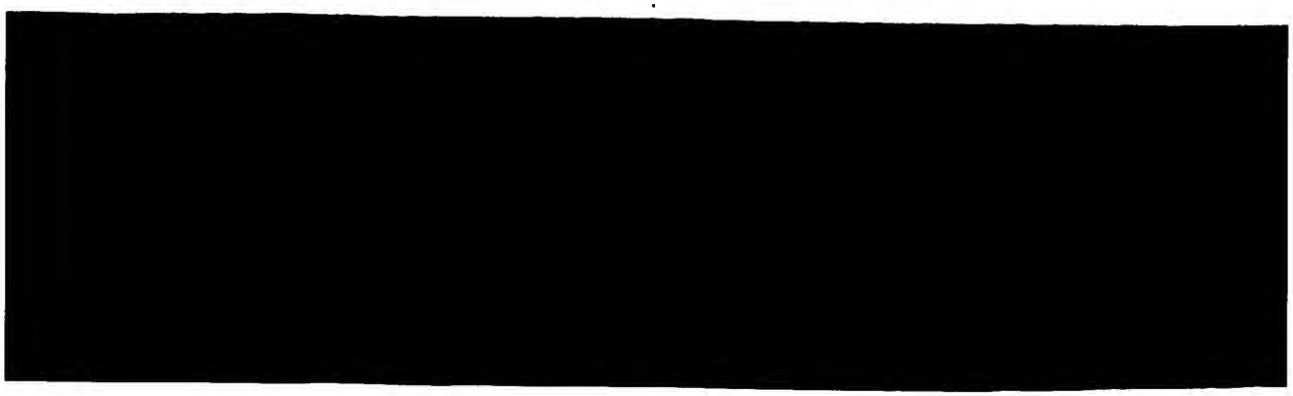
With reference to figure 4 there is shown a racking unit 30 which forms part of the racking system 29. The racking unit 29 includes an upright support 31 with six racks 32 extending laterally from both sides of the upright support 31. Three trays 17 each containing eighteen baskets 10 are positioned on each rack 32. That is, each rack 32 supports one hundred and eight baskets 10. Each racking unit 30 supports six hundred and forty eight baskets 10.

There is also shown the monitoring robot 33 which has six arms 34 extending from each side of the robot frame 35. The six arms 34 are capable of extending across each of the racks 32. (Not all of the arms 34 are shown in figure 4 in order to assist in the understanding of the monitoring robot 33.) The robot frame 35 moves along rails 36 via engagement with the guiding wheel 37. In some embodiments, there is also an overhead rail engagable by a top guide wheel which assists in guiding the robot frame 35. The robot frame 35 moves in a forwards and rearwards direction. The robot frame 35 also has two or more containers 38 for the collection of the molted crustacean. These containers 38 can contain an ice slurry for reducing the physical and metabolic activity of the crustaceans. Each of the arms 34 has three feed apparatus 39 and three cameras 40.

The arrangement of the feed apparatus 39 and cameras 40 is shown more clearly in figure 5. The feed apparatus 39 and cameras 40 are mounted on a slidable platform 41. The platform 41 is supported on L-shaped rails 45 and moves sideways with the assistance of a hydraulic ram 46. The movement of the platform 41 is substantially perpendicular to the forward and rearward movement of the robot frame 35. The feed apparatus 39 comprises a bin 47 and a metering gauge 48 consisting of a slidable plate 49 movable over an aperture (not shown) and actuated by hydraulic ram 50.

Each of the cameras 40 are arranged adjacent respective feed apparatus 39. In this manner images may be obtained during the feeding and harvesting process. To simplify the figures for ease of understanding the invention only a single camera 40 is drawn in phantom on the platform 41 whereas in operation there will be three cameras along platform 41.

There is also shown the harvesting apparatus 55 attached to platform 41. The harvesting apparatus 55 comprises a gripping device 56 movable along a support rail 57. The support rail 57 is pivotally attached to a harvest arm 58 and can be moved about the pivot point with actuation by hydraulic ram 59. In operation the

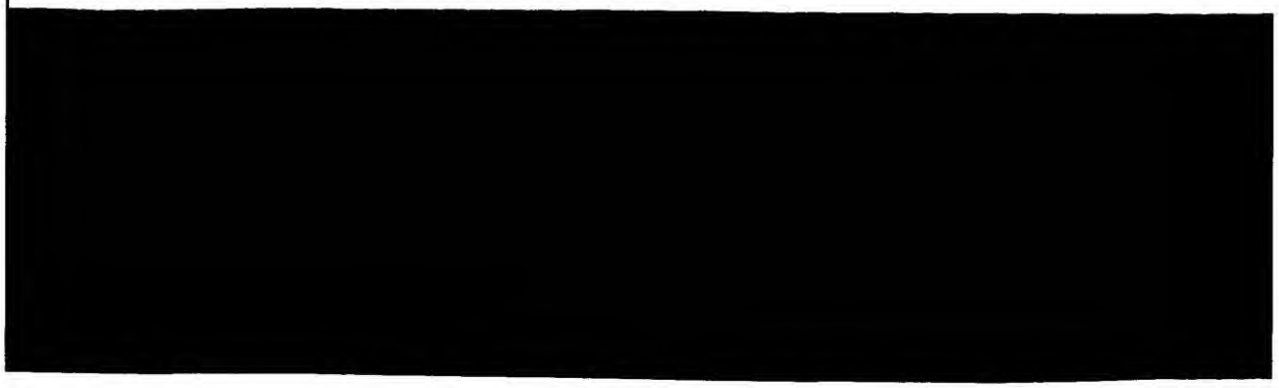


gripping device 56 moves to a basket 10 containing the molted crab, grips the basket 10 by opposing tangs 60 actuated by ram 61, and the basket 10 is raised and inverted so that the molted crab falls into a collection container 38. The molted crab passes into shoot 73 (shown in figure 9) and directed to the collection container 38. The basket 10 is then returned to its position in tray 17. The operation of the harvesting apparatus 55 is shown diagrammatically in Figures 8a to 8c.

The platform 41 is further shown in Figure 6 in perspective with the monitoring robot 33. Again for purposes of understanding the monitoring robot 33 only a single platform 41 is shown and in operation there are six platforms 41 on either side (12 in total) of the monitoring robot frame 35.

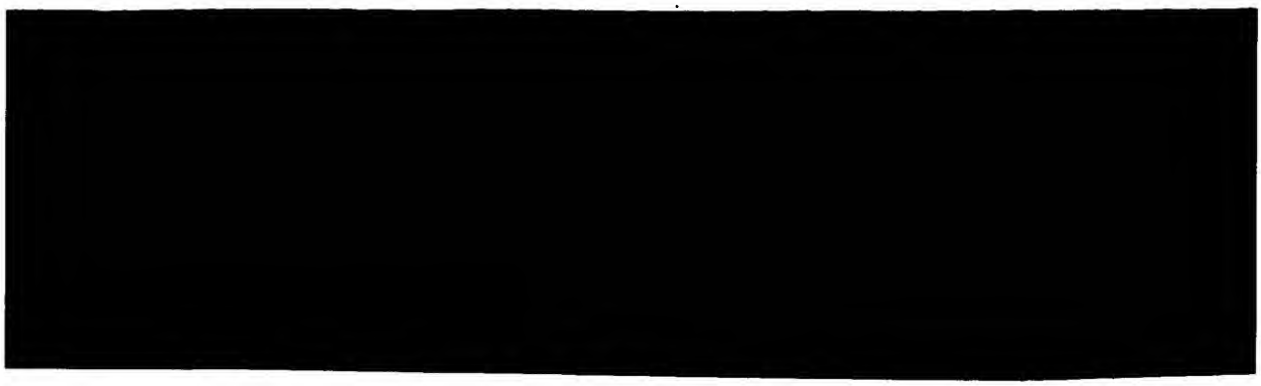
In Figure 7 there is shown six platforms 41 extending from one side of the monitoring robot frame 35. The monitoring robot 33 is positioned in the docking station 65. The docking station 65 serves to service the monitoring robot 33 and reposition the monitoring robot 33 for operation along another row of the racking system 29. This is shown in fig 10. The monitoring robot 33 can move along rails 36 up and down the rows of the racking system 29. When one row has been serviced, the monitoring robot 33 docks with the docking station 65 by moving along aligned rail 36a which forms part of the docking station 65. The docking station 65 then moves along separate rails 66 engaged by guide wheels 67 to the next row. The docking station 65 moves forward and rearward and in a relatively perpendicular direction to the direction of movement of the monitoring robot 33. The docking station 65 has a lower platform 68 and an upper platform 69 accessed by stairs 70. There is also a lift 71 on which collection containers 38 can be raised and lowered from the robot frame 35. There are three collection containers 38 positioned on the robot frame 35 so that the molted crab product is not damaged by its fall from the basket 10.

Figures 10 and 11 provide different views of the racking system 29. The racking system 29 is housed in building 80 wherein the environmental conditions are carefully monitored. In the described embodiment there are approximately 70 racking units 30 in the racking system 29 thereby supporting approximately 36288 baskets 10 (and thus 36288 crabs) at any one time. The operation of the system is dependent on the provision of clean salt water. This is achieved through the water recycling and filtration plant 81 adjacent the building 80.



Waste is discharged from the trays 17 through discharge outlet 21 through pipes (not shown) connecting the discharge outlet 21 with internal piping (not shown) in the upright support 31. The internal piping connects with waste pipes 83 on the floor of the building 80 and discharges the waste to the water recycling and filtration plant 81. Clean salt water from the water recycling and filtration plant 81 is introduced via water pipes 84 in the floor of the building 80, passaged through internal water pipes in the upright support 31 and introduced into individual baskets 10 through pipe 18. Removal of waste and the introduction of clean salt water is preferably coordinated so that the baskets 10 always contain water. The removal of waste and the introduction of clean water may be coordinated by the monitoring robot 33.

In operation each basket 10 in the racking system 29 contains a crab. The monitoring robot 33 moves along the rows of racking units 30 providing food from feeding apparatus 39 to each basket 10 based on the presence of remaining food and approximate crab body weight. Typically the feed is metered so that a crab receives on average 5 grams of feed. The information concerning the presence of remaining food and approximate body weight is determined from images taken from adjacent camera 40. These images are processed by a processor which then transmits instructions to the feeding apparatus 39 regarding the amount of feed to be provided. The information from these images can be used to track the position of the crab in the approximate 30 day molting cycle to give an approximation as to when the crab will next molt. Prior to molting the crab progressively increases then decreases the amount of feed it consumes. The images can also be used to determine whether the crab has molted by the presence of two bodies, one of which is the molted crab while the other is the exoskeleton or shell. If two bodies are detected, the processor provides instructions to the harvesting apparatus 55 to remove the crab to the collection container 38. The crab is removed to the collection container 38 at a predetermined time before a new shell has grown and to provide the best and consistent quality of crab meat product. If the size of the crab is unacceptable for the market, the crab remains in the basket 10 for a further molting cycle. If the size of the crab is acceptable to the market, it is prepared for market eg frozen and packaged or sold live and delivered (by truck 87 for example in fig 10) to a consumer outlet, restaurant or for export.



ADVANTAGES

The advantages of the present embodiment of the invention include individual housing of the crustaceans to avoid loss or damaged product from the aggressive behaviour of the crustaceans; automation of an otherwise labour intensive industry and thereby reducing the cost of the final product; provision of comparatively high quantities of product through intensive farming and automation and providing a consistently high quality product through the monitoring and timing of the molting process.

VARIATIONS

It will of course be realised that while the foregoing has been given by way of illustrative example of this invention, all such and other modifications and variations thereto as would be apparent to persons skilled in the art are deemed to fall within the broad scope and ambit of this invention as is herein set forth.

Throughout the description and claims this specification the word "comprise" and variations of that word such as "comprises" and "comprising", are not intended to exclude other additives, components, integers or steps.

DATED THIS SIXTEENTH DAY OF AUGUST 2002

Watermark Seafoods Pty Ltd

By their Patent Attorneys

Pipers Patent and Trade Mark Attorneys

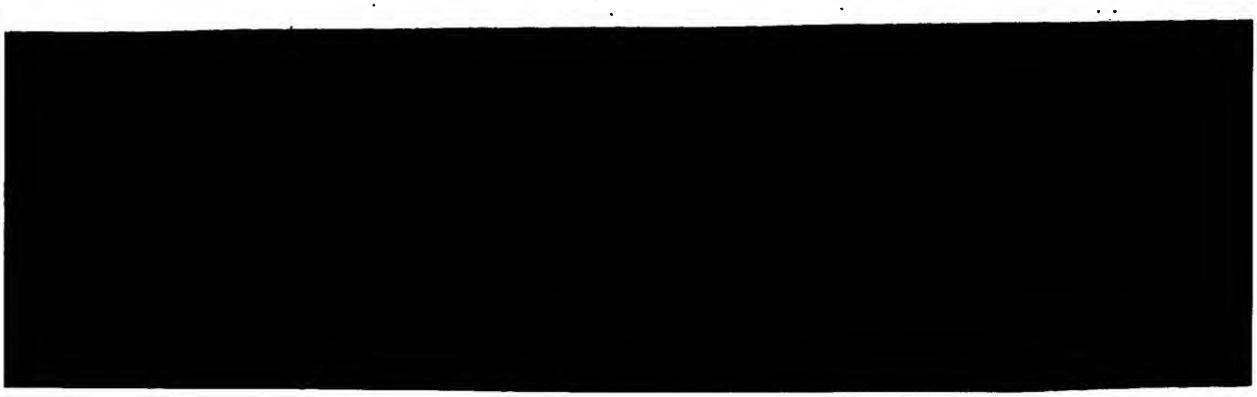
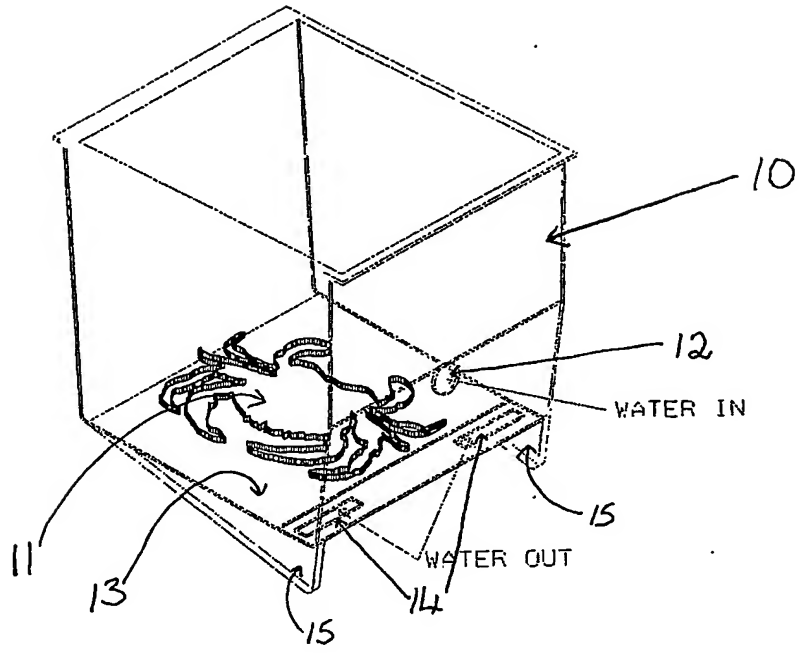


FIG. 1



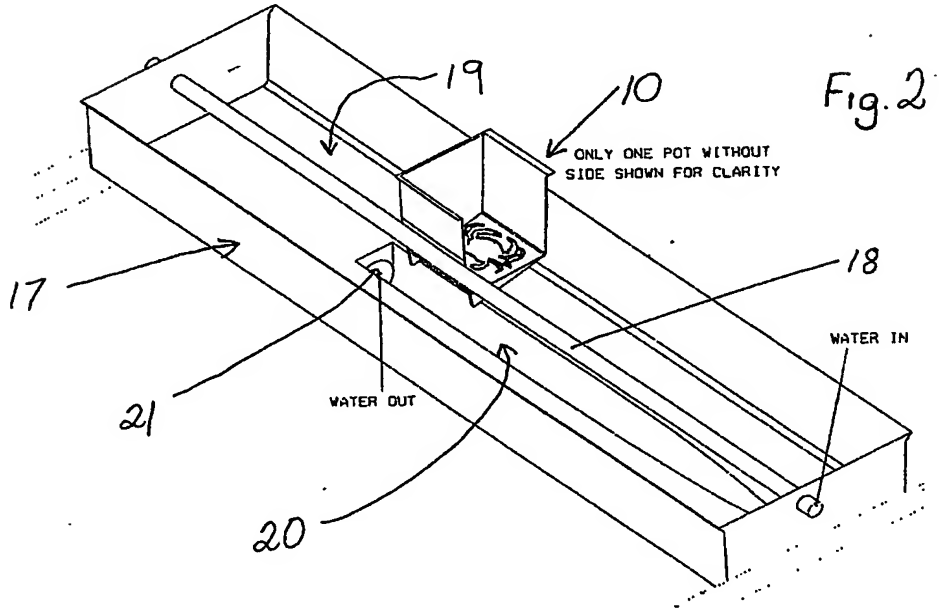


Fig. 2

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Fig3

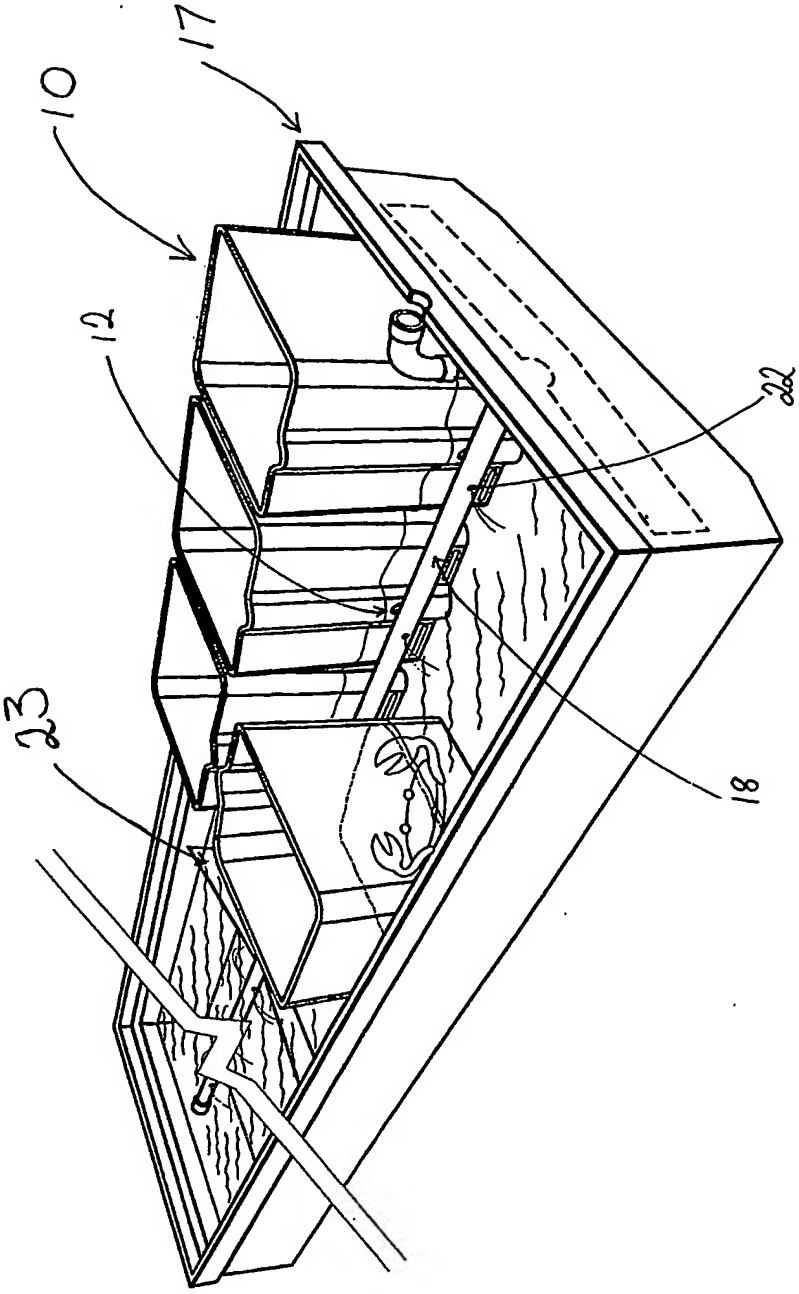
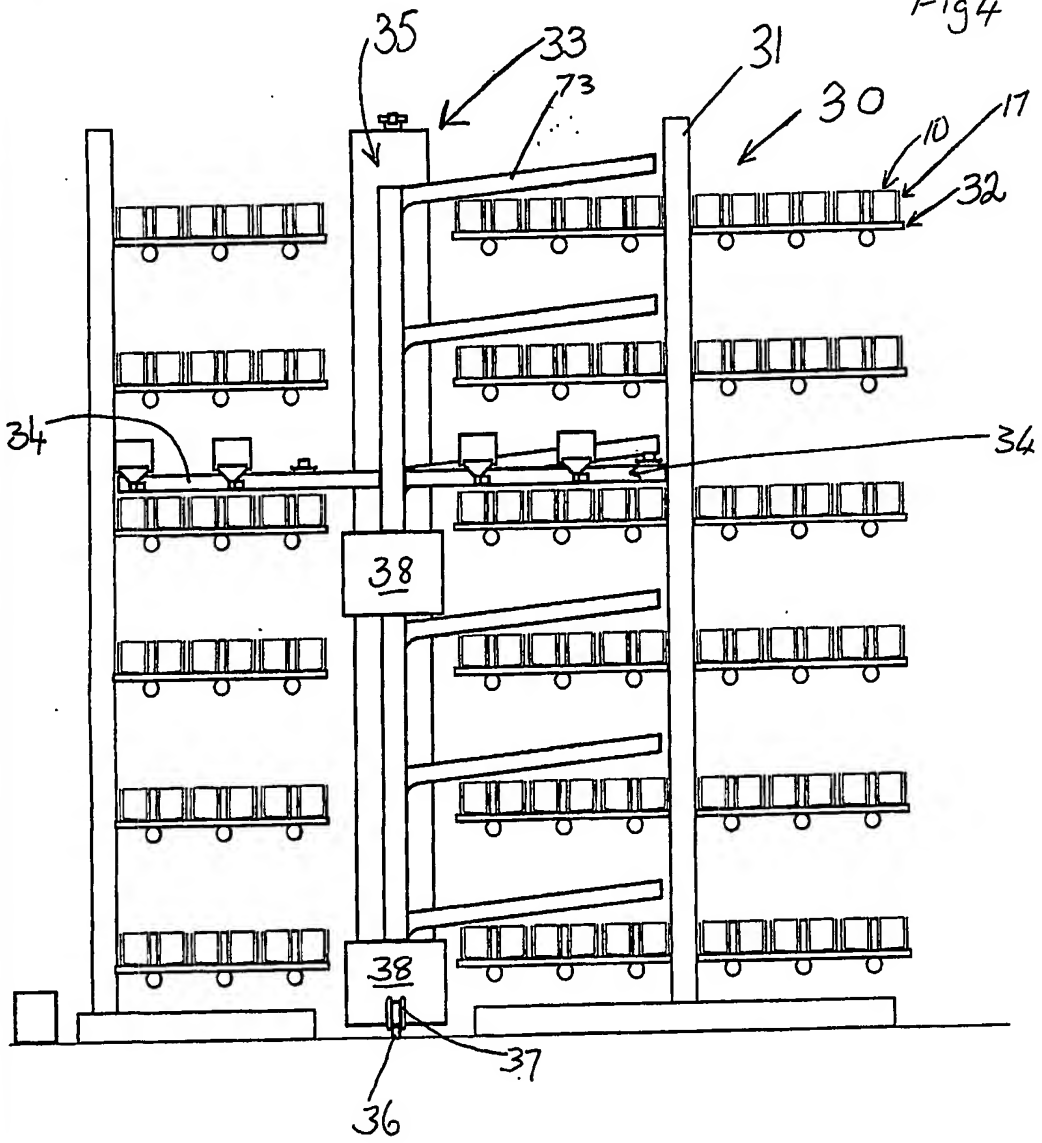


Fig 4



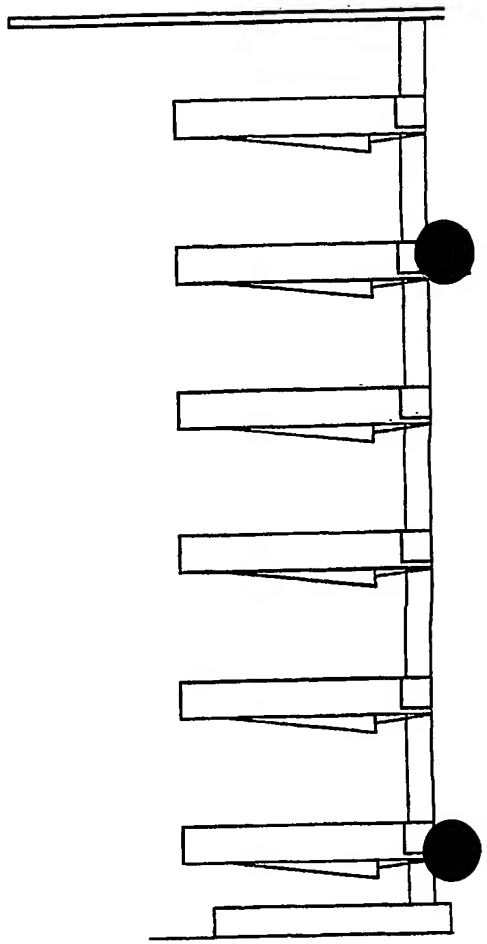
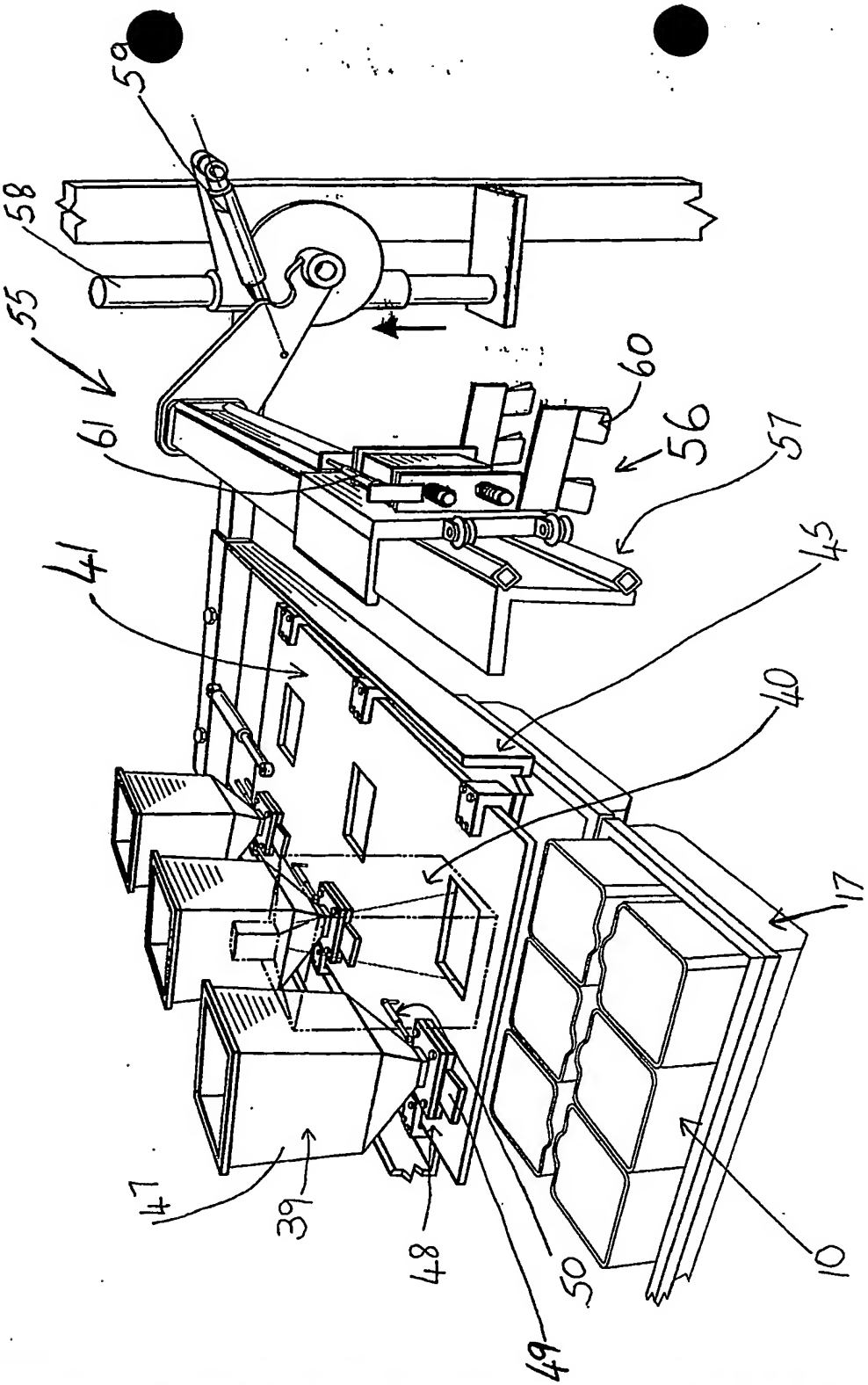


Fig. 5



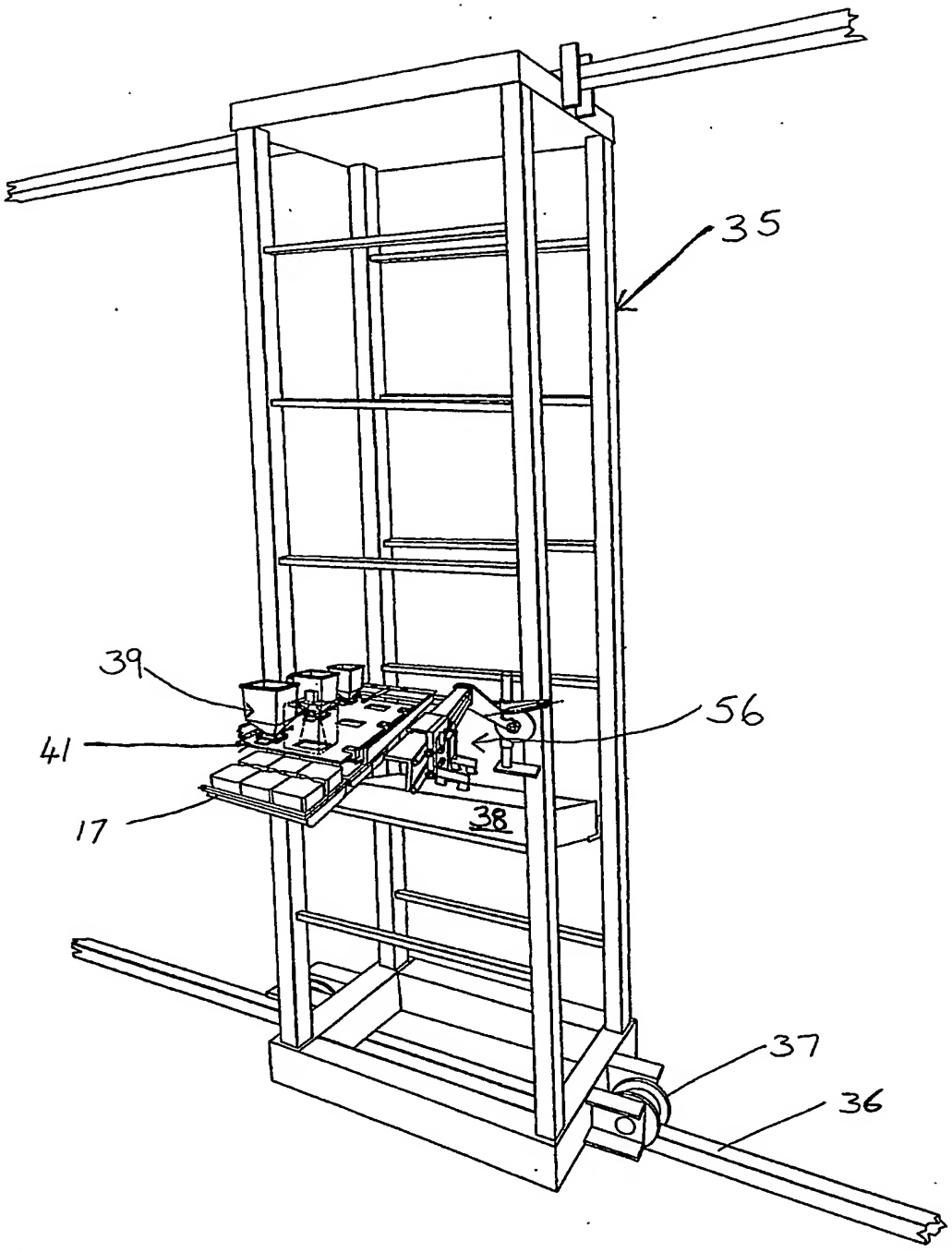

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FIG. 7

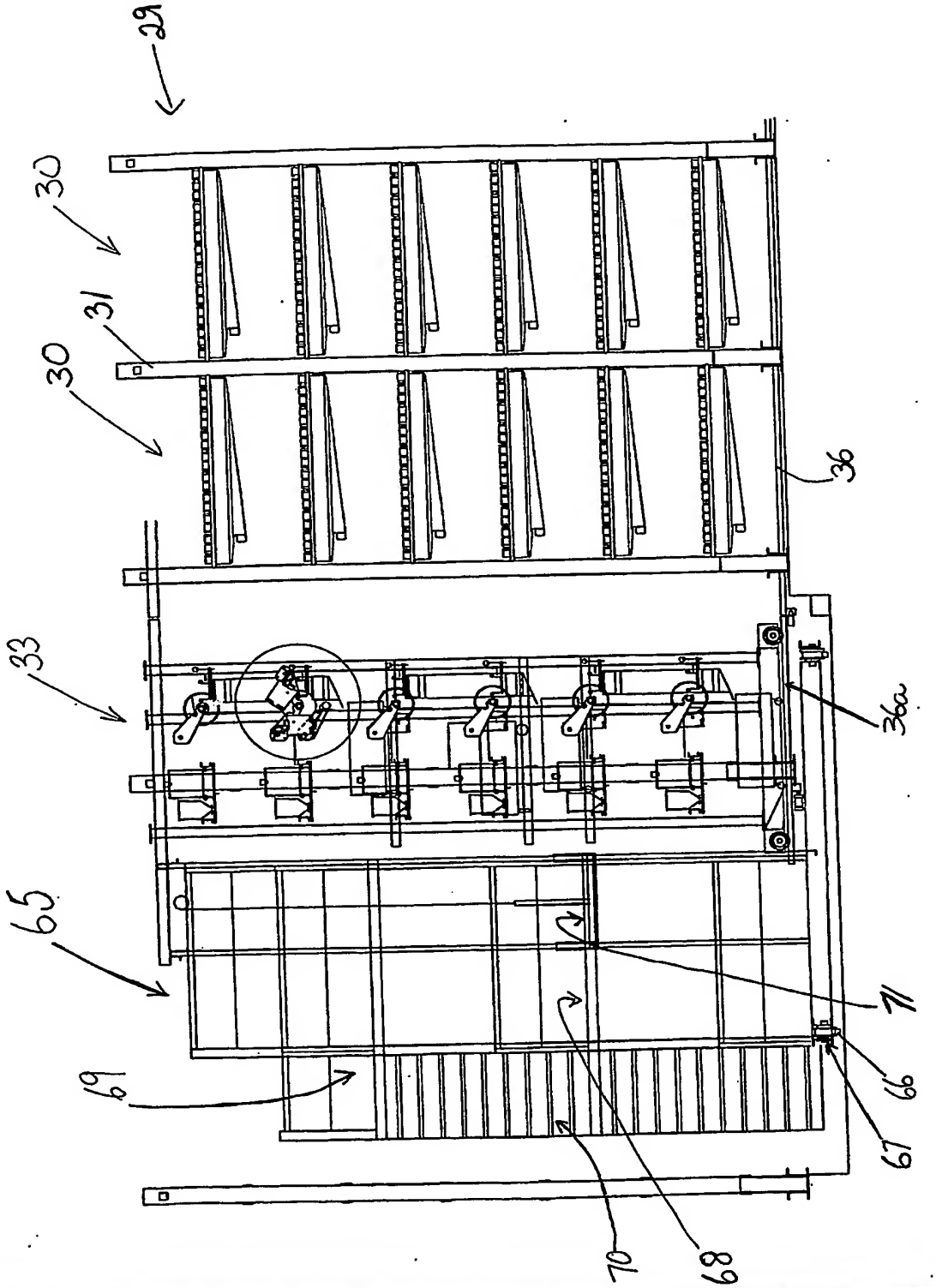
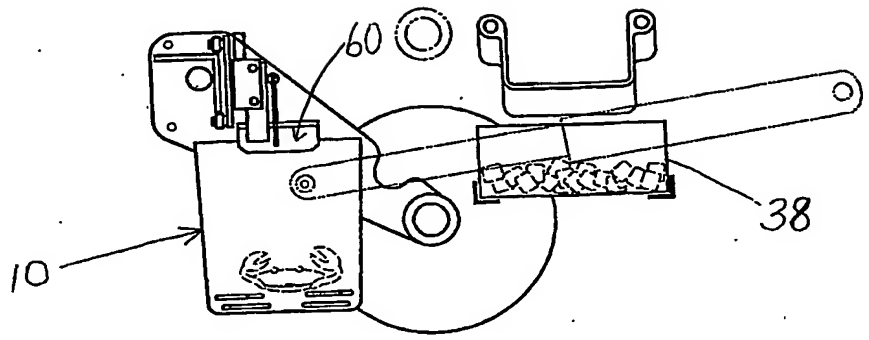
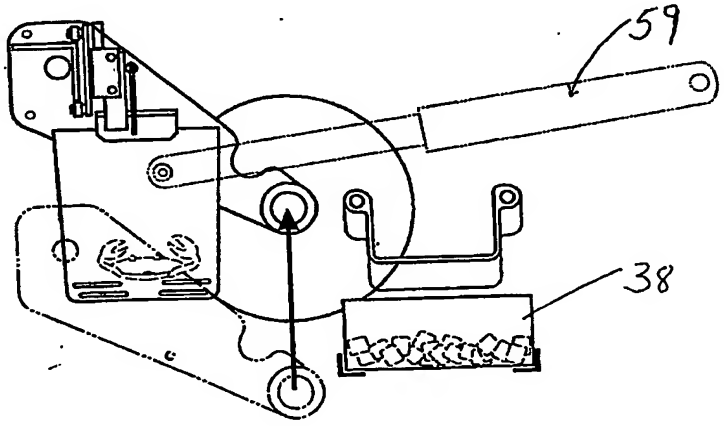


Fig 8

a





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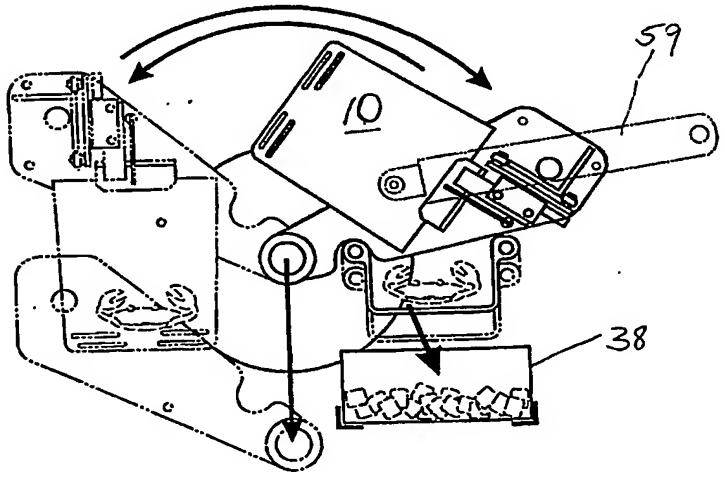

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Fig 7

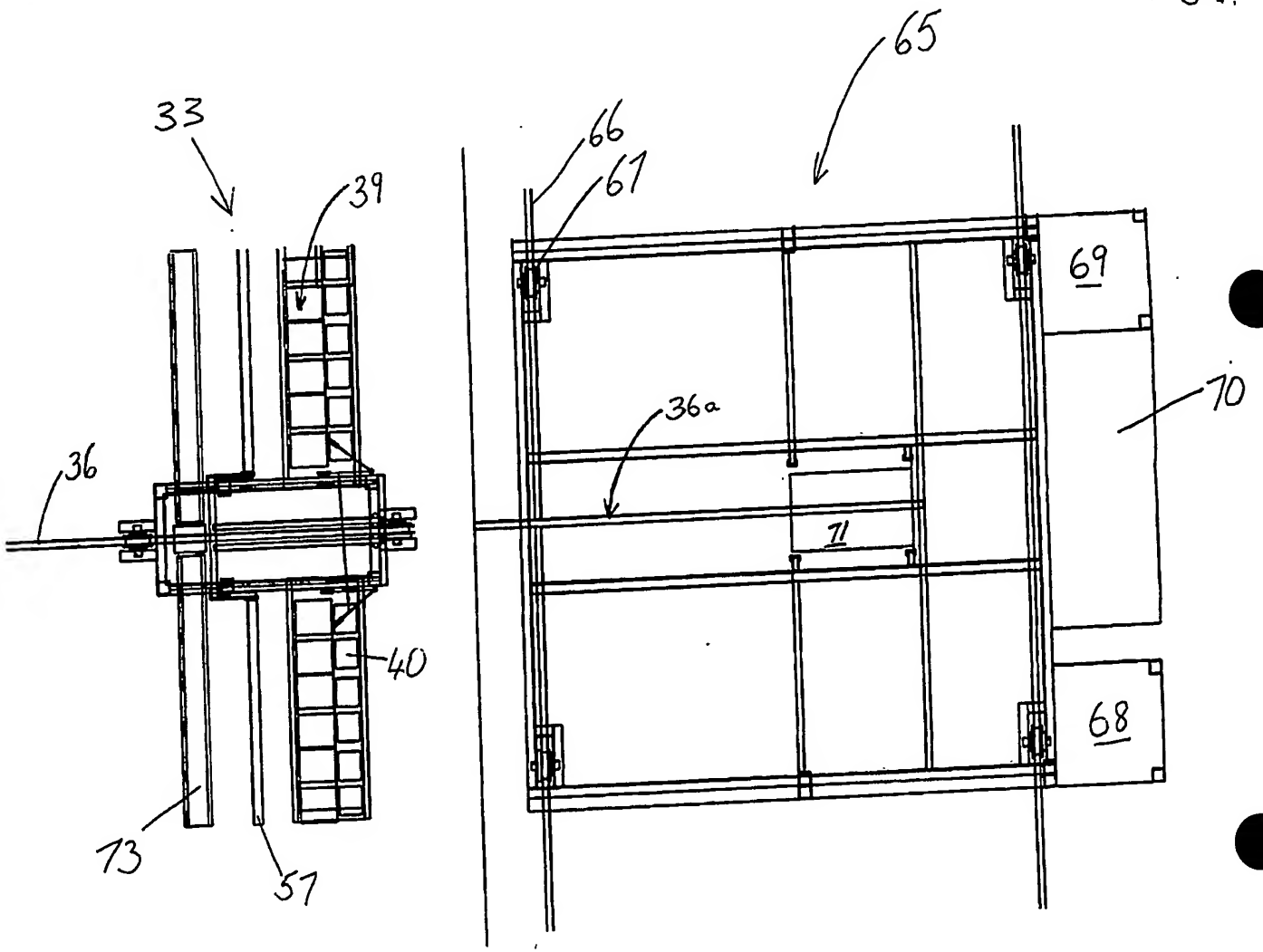

Fig 10.

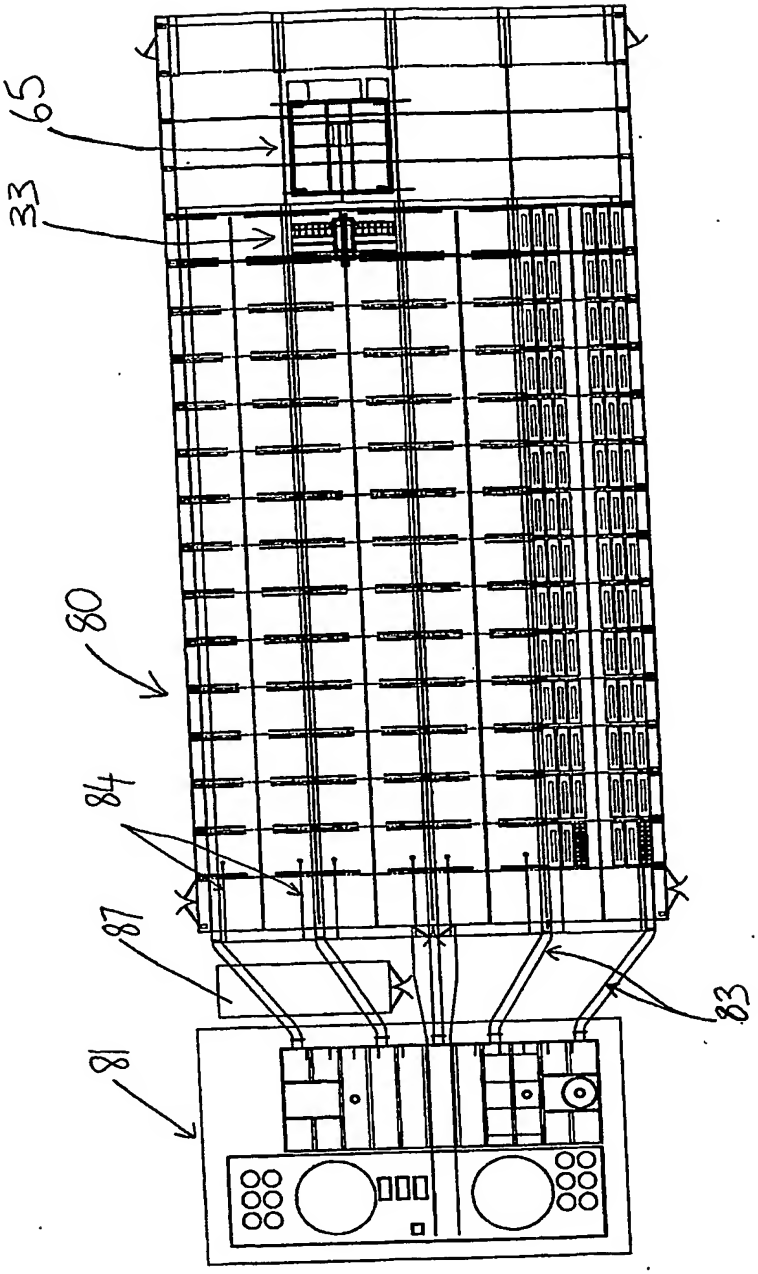

Fig 11